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ABSTRACT

This document examines the past, present, and future of elementary school mathematics. The impact of the modern mathematics movement in the curriculum is assessed and the factors behind the back-to-basics movement are analyzed. The text presents factors considered to be the real basics in mathematics of the eighties based on the recommendations of the National Council of Teachers of Mathematics. The view promoted is that during the coming years, elementary mathematics teachers must be concerned with the logical, social, and psychological criteria of the elementary mathematics curriculum. The neglect of any one of these criteria is seen as a shortchange in students' mathematics education. (MP)

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FASTBACK 152

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Elementary Mathematics: Priorities for the 1980s

Francis M. Fennell

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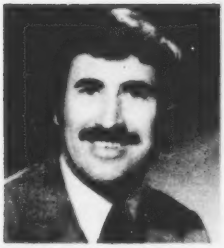

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Elementary Mathematics: Priorities for the 1980s

By Francis M. Fennell

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The New Jersey chapters dedicate this fastback to Ruth Mancuso, in recognition of her educational leadership and service to the school children of New Jersey.

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Introduction

In an era when student competence has become a concern of teachers, parents, administrators, taxpayers, and the media, the elementary mathematics curriculum is being scrutinized with regard to *what* is taught, *when* it is taught, and *how* it is taught. Over the past 30 years no other area of the elementary curriculum has been subjected to so much reform and counter reform. The Sixties generation survived the "new math" but did not thrive on it. The Seventies students know their tables but cannot apply mathematics to solve problems. What's in store for the Eighties?

This fastback will examine the past, the present, and the future of elementary school mathematics. It will assess the impact of the modern mathematics movement on the curriculum and analyze the factors behind the back-to-basics movement. Looking ahead to the decade of the Eighties, this fastback will present what the author considers to be the real basics in mathematics based on the recommendations of the National Council of Teachers of Mathematics.

Historical Perspective

Let's look back 30 or more years and examine the goals of elementary school arithmetic. Morton (1953), in a popular methods textbook of the time, described three criteria for an arithmetic program: 1) the *logical criterion*, which relates to the structure and organization of arithmetic; 2) the *social criterion*, which relates to the usefulness of arithmetic in society; 3) the *psychological criterion*, which is concerned with how children learn. An analysis of these criteria will clarify the theory and practice of arithmetic programs in the 1950s.

The *logical criterion*, or structure of arithmetic, deals with the content in the elementary mathematics curriculum: the use of numbers, adding and subtracting whole numbers, multiplying and dividing whole numbers, operations with fractions, operations with decimals, and problem solving using all operations. Readers familiar with contemporary mathematics programs will recognize that the content in the 1950s is still important in today's programs, but they will also note some interesting differences. For example, in the 1950s the tendency was to delay systematic instruction in arithmetic until grade two and sometimes even until grade three so that teachers could devote more time to the teaching of reading. The logical nature of arithmetic is such that the instructional sequence for whole number operations has remained unchanged for decades. Today the greatest change with regard to the logical criterion has been the earlier introduction of content at kindergarten, first, second, and third grade levels, and the infusion of mathematics-related topics into a previously defined arithmetic program. These changes were a part of the new or modern math movement to be discussed later in this fastback.

During the 1940s and 1950s a very conscious effort was made to provide activities using arithmetic that dealt with real life applications (the social criterion). For example:

1. Planning and serving school lunches,
2. Running a class or school store,
3. Figuring the cost of sodding a lawn,
4. School banking plans,
5. School or class sales,
6. Developing savings stamps plans,
7. Computing the cost of electricity,
8. Map and graph reading.

While the social utility emphasis in arithmetic declined significantly during the modern mathematics era, the present-day concern with both basic skills and problem solving has resulted in a renewal of interest in functional mathematics.

The *psychological criterion*, which is concerned with how children learn arithmetic, became a concern of arithmetic programs in the 1950s. Programs of the day were moving away from the stimulus-response, drill oriented emphasis to an emphasis on meaning in arithmetic. Drill oriented arithmetic programs from 1910 through the 1940s placed major emphasis on the acquisition of skill in computation, with little attempt to show children how these computation skills could be used in daily life.

William Brownell was probably the most influential person in moving elementary arithmetic programs away from a drill emphasis toward a theory of instruction based on meaning or understanding. The meaning theory emphasized the use of number facts and other arithmetic components in a variety of concrete experiences, thus making practice meaningful, not simply repetitive.

Elementary mathematics today still has some of the aspects of both the drill and meaning emphasis. Programs emphasizing individualization in drill and practice are much like the stimulus-response emphasis of the early years of the twentieth century. Typical textbooks today carry out ideas advocated by Piaget, Bruner, Gagné, and others concerning the use of concrete experiences, and problem-solving activities that are similar to Brownell's meaning theory.

As the 1950s drew to a close, arithmetic programs came under scrutiny with regard to what was taught in the classroom (the logical criterion). This review of the logical criterion marked a significant development within the third R, the eventual outcome of which was new or modern mathematics. Let's now examine how the so-called modern math evolved.

The Era of Modern Mathematics

In the mid-1950s scholars in mathematics and education began to examine the content of the arithmetic curriculum. This was a time when there was considerable interest in experimental programs in elementary school mathematics, and funding was available to support research in such programs. The Russians launched the Sputnik satellite in 1957. This technological achievement in the Cold War climate of the time created a sense of alarm. Critics of the schools claimed that the youth of the Soviet Union were much further advanced in mathematics and science and called for drastic reform in mathematics and science programs in our schools. Thus the stage was set for the introduction of several popular elementary mathematics programs, which became known in the 1960s as new or modern mathematics.

But wait! Have you noticed a change in my terminology? What I have formerly been calling arithmetic I am now calling mathematics. This change is not simply semantic nit-picking. Mathematicians tell us that arithmetic is a subset of mathematics and deals primarily with computation, involving whole numbers, fractions, decimals, and percents. The curriculum for the elementary school proposed by the reformers is far broader than arithmetic skills. It includes such mathematical topics as sets, place value, logic, number bases, geometry, probability, statistics, and algebra. These topics, when combined with arithmetic skills, became the focus of the new math programs. Hence, the more comprehensive term, mathematics, has replaced the term, arithmetic, when discussing the elementary curriculum. Actually, the mathematical topics are neither new nor modern; rather they are new to the elementary math curriculum.

Beginning in the 1950s and extending to the mid-1960s there were a number of federally funded experimental elementary mathematics programs which became the models for modern mathematics movement. Most of these experimental programs emphasized changes in the logical criterion or mathematics content at the elementary level. Following are brief descriptions of some of these programs.

The School Mathematics Study Group (SMSG). This, the first modern mathematics program, was funded by the National Science Foundation in the late 1950s. Directed by Edward G. Begle, it was first located at Yale University and later moved to Stanford University. It was the first program to include the use of sets, geometry, and expanded numeration skills for elementary age children. The School Mathematics Study Group also produced secondary school materials. As a model for curriculum development, SMSG was designed to stimulate publishers to create new text materials.

The Greater Cleveland Mathematics Program (GCMP). Developed in the Cleveland area in 1959, the GCMP materials were later published by Science Research Associates. A highly conceptual approach, which also emphasized discovery, GCMP was unique in its attempts to familiarize parents and teachers through televised inservice programs.

The University of Illinois Arithmetic Project. This program used a guided discovery approach to arithmetic and was developed in 1958 as a supplement to a basal text series.

The Madison Project. This program, named for a junior high school in Syracuse, New York, where the program began, was developed in 1957. It was a supplementary program emphasizing discovery teaching of algebraic notions, including functions, coordinate geometry, and graphing. This program was later moved from Syracuse to Webster College in Saint Louis, Missouri. Portions of the project materials were published by Addison-Wesley. Robert Davis, the project director, developed a series of films for use in teacher training.

The Stanford Projects. Developed by Patrick Suppes and Newton Hawley of Stanford University, these programs emphasized the use of sets and geometry at the primary level. The published pupil activities were used initially as supplements to basal programs. The use of sets and geometry in contemporary elementary mathematics programs can

be largely attributed to the influence of the Stanford Projects.

During the heyday of the modern mathematics movement in 1963, an influential study called *The Cambridge Report* was published. This report recommended vast changes in both the elementary and secondary school mathematics programs—once again, primarily in content. The changes recommended were much more drastic than those suggested by most modern mathematics programs. Like much of the thinking in modern mathematics program development, *The Cambridge Report*, written by 25 mathematicians, dealt only in content and did not involve educators or consider the reality of classroom practice. Glennon (1965) noted that if the membership of the Cambridge group had included some teachers, the views expressed in the report might have led to some real curriculum reform.

The modern mathematics movement began to wane towards the end of the 1960s. Hindsight tells us that one of the biggest problems with the new math has been in training teachers. Preparation of elementary school mathematics teachers is still a problem. Historically, many prospective elementary classroom teachers came to college with a limited background and/or a lack of genuine interest in mathematics. The Committee for Undergraduate Preparation in Mathematics (CUPM) in 1965 established guidelines which would require at least some content courses in mathematics for all prospective elementary teachers. As a result some colleges and universities now require as many as 12 credits in math for all elementary education candidates. However, in most teacher preparation programs the requirement is one or two content courses, which is often not enough.

Another problem which generated concern about modern mathematics was the declining test scores, which the media publicized endlessly. Still another problem was the fact that many of the modern math programs presented new content, new vocabulary, and new teaching methods, which were a source of confusion to many parents and the general public. Unfortunately, educators were quite naive when it came to developing effective public relations campaigns to communicate to parents what the new math was all about.

The lack of involvement of classroom teachers in the development of modern mathematics programs may have contributed to the feeling

among teachers that little concern was given to how children learn. Many of these programs used a discovery approach to teaching mathematics that was not consistent with previous arithmetic methodology. Little training was provided in use of discovery teaching. Perhaps the most scathing attack on the new math was Morris Kline's *Why Johnny Can't Add: The Failure of the New Math* (1973). Kline, a mathematics educator himself, indicted the new programs for not teaching computation facts and related skills.

While the new math has come under heavy criticism, it would be unfair to say it has not made some important contributions to mathematics education today. The use of sets has been accepted as the predominant introductory method for basic number concepts and whole number operations. Geometry has also become an important and enjoyable portion of mathematics at the elementary level, beginning in most programs at kindergarten. The impact of modern mathematics with regard to the structure of the number system, principles and properties, probability and statistics, and the emphasis on place value has been retained in virtually all contemporary programs, because educators have recognized that these topics have great value for pupils at the elementary level.

A Renewed Concern for Instruction and Learning Theory

As the popularity of the modern mathematics movement ebbed, educators turned their attention to the *psychological criterion* of mathematics education. The thrust changed from a concern with the structure of mathematics content to a concern with how to organize instruction to facilitate learning.

The mid-1960s to early 1970s saw the rise in popularity of individualized instruction in mathematics. Beginning with Individually Prescribed Instruction (I.P.I.), a number of carefully programmed instructional models emerged. The sequence in these programs usually includes a pretest on a particular topic, followed by appropriate instructional activities based on the pretest, and culminating in a posttest. Robert Thorndike's stimulus-response learning theory and the learning hierarchies of Robert Gagné contributed significantly to the learning strategies employed in individualized programs.

Patrick Suppes of Stanford University pioneered individualized computer-assisted instruction in mathematics. Today such pioneering efforts have been adapted for microcomputers, which are being used in the home as well as schools. Several school districts have purchased or devised their own individualized programs, and in some cases, use the district computer to aid in instruction, record keeping, and other management functions.

Westinghouse's Project P.L.A.N. is a unique computer-based individualized mathematics program that actually assumes the teacher/pupil planning function. Each day individual pupil results are fed to the computer where they are scored, and, based on the results,

the computer provides a daily individual instructional program for each student. Montgomery County, Maryland, has since developed an individualized program similar to Project P.I.A.N. in managing elementary mathematics instruction.

Although a variety of individualized programs are still popular today, they are used primarily as supplements to basal programs or for special programs. The major disadvantages of these programs are costs and the teacher time needed to update and record pupil progress. An additional concern for many teachers is keeping track of where the class is within the curriculum. Teachers using a basal text can say, "Well, today we'll be working with two-digit divisors in whole number division," but in an individualized setting this is not possible without checking on the status of every pupil. This role change, from tightly controlling the content to one of managing instruction, has been an unsettling one for many teachers.

Today, individualized programs seem most appropriate at the upper elementary level as either program supplements or extensions. However, microcomputer instruction will be a topic of great interest in the 1980s. Use of microcomputers for computational drill and practice is already available and seems to be quite successful.

Concurrent with the development of individualized programs was the renewed interest in Jean Piaget's theories on cognitive development. Out of his clinical research with children, Piaget identified distinct stages of cognitive growth that have important implications for mathematical learning. Although the age ranges may vary, Piaget's stages of cognitive development are:

1. Sensory Motor stage—birth to age 2
2. Pre-Operational stage—age 2 to age 7
3. Concrete Operational stage—age 7 to age 11
4. Formal Operational stage—age 11 to adult

Piaget's stages of cognitive development have been influential in popularizing the use of manipulative materials for developing mathematical concepts. Math programs today, almost without exception, include the use of manipulatives for concept development at the preoperational and concrete operational stages. Further, in the past 10

years Piaget's theories have had a strong impact in courses in math teaching methods.

The British Nuffield Project, a prototype of open education in the U.S., was one of the first to emphasize Piaget's ideas in the form of activity-centered mathematics laboratories. With a learning by doing approach, the math laboratory approach emphasized the use of manipulatives, games, inquiry-related discussions, experiments, and flexible pupil grouping. Some have criticized this approach to learning math as being nothing but "fun and games." Others saw problems because of the lack of structure and no consistent idea of what to expect from pupils. Nevertheless, Piaget's ideas have provided elementary school math teachers with a better understanding of developmental learning in the mathematics curriculum.

From the early to mid-1970s individualized programs and math laboratory programs continued to be popular and still emphasized modern mathematics. But during this period a growing uneasiness emerged in the U.S. regarding the effectiveness of public education; elementary mathematics became a prime target of the so-called back-to-basics movement. This movement, as we shall see in the next section, brought pressures for changes in elementary mathematics content, social applications, and instructional techniques, which have continued into the 1980s.

Back-To-Basics in Elementary Mathematics

What are the basic skills? What caused the back-to-basics movement? These two questions must be addressed in context with two related issues in U S. education, accountability and minimum competency. In 1978 the National Council of Supervisors of Mathematics (NCSM) reported that the back-to-basics movement in mathematics evolved as a result of:

1. Declining scores on standardized achievement tests and college entrance examinations;
2. Public reaction to the National Assessment of Educational Progress tests;
3. Rising costs of education which brought demands for greater accountability;
4. Movement in mathematics education away from an emphasis on content to one emphasizing instructional methods;
5. Concern over the need to provide remedial and compensatory programs;
6. Widespread publicity given to each of the above by the media.

With the back-to-basics movement the content of elementary mathematics programs began to move away from modern mathematics concepts to an almost exclusive emphasis on computational skills. Drill and practice activities once again became important. Textbook-based teaching again became prominent, and activity-centered materials and individualized programs declined in popularity. Publishers of supplemental materials deluged the market with all forms of practice activities. Some publishers even advertised their materials as "old fashioned" or "traditional drill and practice" activities.

Let's examine some of the data which helped bring about a national concern for basic skills in mathematics. The National Assessment of Educational Progress (NAEP) in mathematics, first completed in 1973, tested a national sample of students at ages 9, 13, and 17. Results of the first NAEP tests in mathematics indicated computational deficiencies at all three age levels. The publicity given these 1973 NAEP results was a major impetus in the back-to-basics movement.

A related development in the quest for basics has been the minimum competency testing movement. Today over 30 states use some sort of testing to assess minimum competencies in mathematics and other areas. Several states are also requiring that students pass such tests in order to graduate from high school. These competency tests are, for the most part, assessing mastery of content that is the responsibility of the elementary mathematics teacher.

Many elementary mathematics teachers seem to be happy teaching the basic skills. They will tell you they never asked for modern mathematics or individualized programs in the first place. It was forced on them, they say. Besides that, basic computational skills are easier to teach. As I travel to elementary schools in a variety of communities, I become more convinced that there is a dangerous national preoccupation with achieving computational mastery at a particular level to the neglect of a comprehensive mathematics education. This back-to-basics whiplash is of great concern to many mathematics educators today. Have teachers forgotten what a complete mathematics curriculum at the elementary level is? Have teachers forgotten such factors as readiness? Have teachers forgotten the social uses of mathematics in problem-solving settings? These questions need to be raised in classrooms where computational drill and practice have in fact become the curriculum.

From 1977 to the present there has been a conscious effort by mathematics educators to define what basic skills in mathematics are, but also to communicate that practice in computational skills does not alone make an elementary mathematics curriculum. The National Council of Supervisors of Mathematics (NCSM) published in 1977 a list of what it considers to be basic skills in mathematics. A review of these 10 skill

areas will show that what NCSM considers to be basic is much more than computational skills, although they are not neglected. The skill areas are:

1. Problem Solving—solving problems that are new to students;
2. Applying mathematics to everyday situations—using math to deal with daily life situations;
3. Alertness to the reasonableness of results—checking results to note their proximity to expected solutions;
4. Estimation and approximation—using estimation for measurement and mental computation;
5. Appropriate computational skills—use of addition, subtraction, multiplication, division of whole numbers, decimals, and fractions;
6. Geometry—knowledge of the basic ideas related to common geometric figures;
7. Measurement—ability to use both standard and metric measurement;
8. Tables, charts, and graphs—ability to read, construct, and interpret tables, charts, and graphs;
9. Using mathematics to predict—using probability to predict events;
10. Computer literacy—familiarity with the computer and its potential use.

Several contemporary textbook programs are now using the NCSM basic skills list as a guide to insure a varied yet complete curriculum in elementary school mathematics.

The back-to-basics movement has been helpful in reminding educators that basic computational skills should not be neglected. However, the basic skills need to be continually revised in terms of the contemporary needs of our society. Also the strides made in instructional methods based on how children learn should not be lost in a maze of computational drill worksheets. As we shall see in the next chapter, mathematics educators are now concerned that an over-indulgence in basic skills seems to be producing students who lack mathematical problem-solving ability.

The Need for Problem-Solving Skill

In September 1979 the National Assessment of Educational Progress (NAEP) released the results of its second survey of mathematics achievement, which indicated changes from the first survey in 1973. Basically, the report showed that while computational skills were satisfactory, the ability to solve problems had declined during the 1973-1978 period. As Thomas Carpenter has noted, students tested "demonstrated a lack of even the most basic problem-solving skills." These results, coupled with the continuing decline of Scholastic Aptitude Test (SAT) scores and with lower scores on other standardized tests, again raised concern about our national deficiencies in mathematics achievement.

The ability to apply mathematics to solve problems is at least as fundamental as computational skill. In fact, the basic purpose of learning mathematics is to be able to solve problems. Listed below are the types of problems pupils might encounter in the elementary mathematics classroom:

1. Choosing the operation—word or oral problems where the student must determine which basic operation(s) to use in order to complete the necessary computations;

2. Data Collecting—problems where the student must collect the appropriate information to be used in problem solution. Pupil experimentation may be needed for this type of problem;

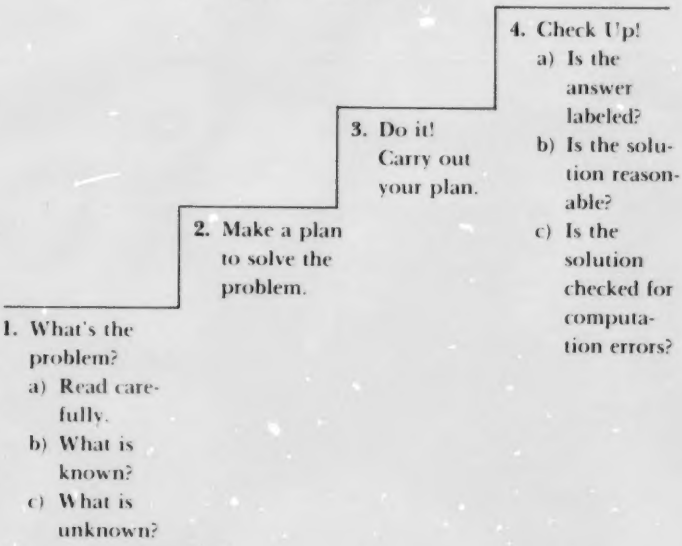
3. Data Organizing—problems involving tables or the setting up of lists of data needed for problem solution;

4. Estimating—problems where the student must make estimates to solve or check the problem;

5. Logic—problems involving the use of thinking strategies where the solution is not obvious.

Much needs to be done to help teachers with instructional techniques in teaching problem solving in mathematics. Teaching problem solving doesn't necessarily follow the neat sequential structure of teaching computational skills. It is often time consuming. A strategy I have found useful is the problem-solving staircase (see chart below), which presents a four-step sequence to follow in attacking a mathematical problem. By using the problem-solving staircase, pupils and their teachers can pinpoint difficulties at each step of the sequence and correct them before moving on to the next step in the problem solution.

Problem-solving Staircase


4. Check Up!
a) Is the answer labeled?
b) Is the solution reasonable?
c) Is the solution checked for computation errors?
3. Do it! Carry out your plan.
2. Make a plan to solve the problem.
1. What's the problem?
a) Read carefully.
b) What is known?
c) What is unknown?

Elementary Mathematics Agenda for the 1980s

The major professional organization in mathematics education, the National Council of Teachers of Mathematics (NCTM), has responded to the narrow focus of the back-to-basics movement and to the decline in mathematics achievement with recommendations that will direct mathematics education in the coming decade. At its national conference in 1980, NCTM announced its *Agenda for Action: Recommendations for School Mathematics of the 1980s.* Following are the recommendations:

1. *Problem solving should be the focus of school mathematics in the 1980s.*

Some implications of this recommendation are:

a. That elementary mathematics curriculum will need to be reorganized to emphasize problem solving.

b. Teachers and students will need to devote more classroom time to the inquiry approach, which is, in fact, a problem-solving strategy.

c. A scope and sequence of problem-solving skills will need to be determined for various elementary school levels.

d. A greater variety of materials are needed for the classroom teacher to teach problem solving. Computers and calculators should be considered for use in problem solving.

2. *The concept of basic skills must encompass more than computational facility.*

Some implications of this recommendation are:

a. Elementary mathematics programs must move beyond routine

computational use, especially in an era when calculators and microcomputers are readily available in many homes.

b. The National Council of Supervisors of Mathematics' position statement on basic skills will serve as an updated and expanded view of what is meant by basic skills.

c. Curriculum materials should be developed for expanding the notion of basic skills.

3. *Mathematics programs must take full advantage of the power of calculators and computers at all grade levels.*

Some implications of this recommendation are:

a. Elementary classroom teachers will need to incorporate the use of the calculator and microcomputer into the classroom.

b. Materials are needed to provide unique ways in which to use the calculator in the elementary classroom.

c. Elementary teachers at the pre- and inservice levels will need to become literate in the use of calculator and computer.

4. *Stringent standards must be applied to the teaching of mathematics.*

Some implications of this recommendation are:

a. Elementary classroom teachers, especially at the primary level, will need to devote more time to the development of mathematics concepts and their use in problem solving.

b. Attention to effective classroom management will continue to be essential for optimum efficiency in teaching mathematics.

c. Teachers will need to use varied grouping strategies and manipulative and media-related instructional materials; they will need to sequence their lessons to allow time for development, questioning, practice, and reinforcement.

5. *Mathematics programs and student learning must be evaluated by a wider range of measures than conventional testing.*

Some implications of this recommendation are:

a. Teachers should use a variety of evaluative measures in determining individual pupil achievement, aptitude, and attitude.

b. Minimum competency testing should be viewed as measures of student achievement that represent only minimum skills. They

should not be considered as a standard for evaluating student achievement.

c. Educators at all levels need to understand how to construct, use, and interpret tests.

d. Diagnostic techniques should be an integral part of all elementary teachers' preparation.

e. Mathematics programs should be evaluated by matching program goals with evaluative strategies.

f. Educators need to evaluate systematically basal texts and other supplemental materials commonly used in mathematics classrooms.

g. Elementary classroom teachers should be evaluated continually with regard to their effectiveness in teaching mathematics at their level.

6. *More mathematics study must be required for all students with a flexible curriculum to accommodate the diverse needs of the student population.*

Some implications of this recommendation are:

a. Elementary classroom teachers need to deal with individual learning styles and be able to assess pupil readiness for developmental learning.

b. Elementary programs for gifted students in mathematics are to be encouraged. Curriculum for the gifted should provide a variety of problem solving opportunities rather than an accelerated program.

7. *Mathematics teachers must demand of themselves and their colleagues a high level of professionalism.*

Some implications of this recommendation are:

a. Teacher education programs should provide opportunities for teachers to develop the skills and strategies recommended for mathematics teaching in the 1980s.

b. School districts should explore alternatives to traditional in-service programs that will allow for teacher growth based on individual need.

8. *Public support for mathematics instruction must be raised to a*

level commensurate with the importance of mathematical understanding to society today.

One implication of this recommendation is:

a. Educators must find ways to communicate to the public the recommendations for mathematics education in the 1980s.

The NCTM recommendations for the 1980s clearly point toward problem solving as the base of all mathematics offerings. The challenge facing teachers is to implement these recommendations in the coming decade.

Summary

The third 'R' has certainly undergone many changes in the last 35 years. The modern mathematics movement of the 1960s altered the content at the elementary school level with the introduction of a variety of true mathematics topics. In the mid-1960s to early 1970s the learning theories of Piaget, Gagné, Bruner, and others made an impact on the instructional approaches to the elementary mathematics curriculum. By the mid-1970s reaction against modern mathematics, along with lower standardized test performance and demands for accountability, resulted in the back-to-basics era. This movement, still popular in many areas, focused primarily on computational drill and practice, which contemporary critics charge is a watering down of the elementary mathematics curriculum because it neglects the problem-solving applications of mathematics. Currently, elementary school mathematics is embarking on a decade of problem solving.

Implementation of a total elementary mathematics program rests heavily on the shoulders of the classroom teacher. Teachers will need a strong base of both mathematics content and up-to-date methodology in their preservice preparation. To meet the challenges of the 1980s teachers must develop skills in diagnosis and assessment, use of the calculator and computer, and problem-solving approaches to mathematics instruction. And teachers must have an understanding of contemporary learning theory as it relates to elementary mathematics.

In the 1980s inservice topics for elementary mathematics teachers will include: strategies for problem-solving, the gifted student, technology and teaching, diagnosis and prescription, appropriate use of testing and assessment, and the use of games and manipulative activities.

During the coming years elementary mathematics teachers must be concerned with the *logical*, the *social*, and the *psychological* criteria of the elementary mathematics curriculum. The neglect of any of these criteria will shortchange our children's mathematics education. The challenge is a great one.

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